Strategic environmental standards and the role of foreign direct investment

著者	黒田 知宏
journal or publication title	THE NAGOYA GAKUIN DAIGAKU RONSHU; Journal of Nagoya Gakuin University; SOCIAL SCIENCES
volume	45
number	4
page range	103-110
year	2009-03-31
URL	http://doi.org/10.15012/00000283

Strategic environmental standards and the role of foreign direct investment *

Tomohiro KURODA †

1 Introduction

Worldwide environmental destruction has been attracting considerable attention. Obviously, emissions from production activities are the major causes of the environmental problems. When firms generate emissions, the conventional wisdom says that the government should intervene to restrict the production. Environmental standards are typical policy measures for this purpose. The standards restrict the level of production and hence the negative externalities generated by emissions are internalized.

In this age of globalization, however, production and consumption may not be done at home. For example, by undertaking foreign direct investment (FDI), firms may not produce in their own countries. The differences in the pollution regulation among countries might cause the pollution activities to be relocated in the countries with relatively lower pollution regulations. When the domestic government adopts tough environmental regulations, domestic firms may shift their plants abroad.[1] Attracting FDI generates employment. If emission regulations are loose enough abroad, for example, environmental damages could become worse as a result of the plant relocation. That is, there usually exist multiple markets. Thus, the framework of an open economy is indispensable to examine emission regulations.

These arguments above show that the relationship between the environmental policy and the foreign direct investments becomes more important issue. Nevertheless, there are limited literature on the interaction between them. Barrett [1994] deals with strategic environmental standards in the third-country model, however, his model does not contain the foreign direct investments.

The purpose of this paper is to shed light on the effects of FDI on emission regulations in the open economy. We consider the strategic aspects of environmental standards with or without FDI, and analyze the role of cooperation.

The rest of the paper is organized as follows. Next section contains the cases where emissions are

＊ Author acknowledges the Grant-in-Aid for Research from the Research Institute of Nagoya Gakuin University in 2006.

† Faculty of Economics, Nagoya Gakuin University, Nagoya, Aichi 456–8612, Japan; Phone: +81–52–678–4080, Fax: +81–52–682–6812; E-mail: tkuroda@ngu.ac.jp

1　See Markusen, Morey, and Olewiler [1993, 1995], Kayalica and Lahiri [2000] for example.

generated by production. Our analysis focuses on the effectiveness of environmental standards. The last section concludes the paper.

2 The basic model

In this model there are two exporting countries (labeled by 1,2) and one consuming(third country) country. There is one firm in each exporting country which operates for the oligopolistic market of a homogeneous good in the consuming country.

The inverse demand function of the oligopolistic good is given by:

$$p=\alpha-\beta D, \tag{1}$$

where D is the total consumption in the third country.

$$D=x_1+x_2, \tag{2}$$

where x_i is the output of oligopolistic good produced by country(firm) $i=1, 2$. Production of the good causes local pollution. Firms have the pollution abating technologies. The governments regulate the local pollution by setting a quantity restriction by emission standards. Average (and marginal) costs of producing firm are, given the environmental standards set by the governments,

$$k_i=c_i+\mu(\theta_i-z_i). \tag{3}$$

c_i is a constant per unit cost determined by the production technology and factor market conditions. μ is a constant unit cost of abatement, θ_i is the gross pollution per unit, and $z_i\in(0,\ \theta_i)$ is the maximum quantity of pollution per unit that the firms are allowed to emit into the atmosphere. Note that the smaller z means the stricter environmental restriction.

The profits are given by:

$$\pi_i=(p-k_i)x_i. \tag{4}$$

We assume that there are unemployment in countries 1 and 2. Following Brander and Spencer [1987], factor input costs are taken to be the income of the factors which would remain unemployed in the absence of the production of the oligopolistic good. Hence the welfare levels of the country 1 and 2 are given by following W_i.

$$W_i=c_ix_i+\pi_i-\phi_ix_iz_i, \tag{5}$$

where ϕ_i is the marginal dis-utility of environmental damage.

We consider the two different scenarios, (see descriptions below), with or without FDI.

・Scenario 1: No FDI appears. Each firm operates in its own country. Profit belongs to the country

where it operates.

1. Assuming that the firms behave in a Cournot-Nash fashion, we characterize the optimal z_i which will maximize each country's welfare.
2. Moreover, we consider the uniform policy reform from non-cooperative equilibrium. We can show that the reform turns to be welfare-improving.
3. We characterize the cooperative equilibrium levels of z_i^c.

・Scenario 2: Firm located in the country 1 is owned by the foreign multinationals of the rest of the world. Profit of the firm 1 no longer belongs to country 1.

1. Assuming that the firms behave in a Cournot-Nash fashion, we characterize the optimal z_i which will maximize each country's welfare.
2. Moreover, We characterize the cooperative equilibrium levels of z_i^c .
3. We reconsider the role of the FDI and the levels of restriction.

3 Without Foreign Direct Investment

3.1 Non-cooperative equilibrium

The Cournot-Nash non-cooperative equilibrium output is obtained by first order conditions of profit maximization.

$$x_i=\frac{\alpha+k_j-2k_i}{3\beta}. \tag{6}$$

Totally differentiating x_i and π_i, we obtain:

$$dx_1=\frac{2\mu}{3\beta}dz_1-\frac{\mu}{3\beta}dz_2, \tag{7}$$

$$dx_2=-\frac{\mu}{3\beta}dz_1+\frac{2\mu}{3\beta}dz_2, \tag{8}$$

$$d\pi_i=\frac{4\mu}{3}x_i dz_i+\frac{-2\mu}{3}x_i dz_j. \tag{9}$$

Totally differentiating W_i, we have following formulas:

$$3\beta dW_1=A_1dz_1+A_2dz_2, \tag{10}$$

$$3\beta dW_2=A_3dz_1+A_4dz_2, \tag{11}$$

where

$A_1=[2\mu(c_1+2\beta x_1)-\phi_1(2\mu z_1+3\beta x_1)]$,

$A_2=\mu[\phi_1 z_1-c_1-2\beta x_1]$,

$A_3=\mu[\phi_2 z_2-c_2-2\beta x_2]$,

$A_4 = [2\mu(c_2+2\beta x_2) - \phi_2(2\mu z_2+3\beta x_2)]$.

We discuss first the direct effects of each government's environmental policy on the welfare. When country 1 reduces z_1 ,*i.e.* $dz_1<0$, the total environmental damage in the country 1 is reduced. Thus, the benefit of reducing environmental damage is given by second term in A_1, $[-\phi_1(2\mu z_1+3\beta x_1)]dz_1>0$. Tougher standard is good for environment, however, the domestic production shrinks and unemployment expands. These deficits are given by the first term in A_1, $[2\mu(c_1+2\beta x_1)]dz_1<0$.

Second, we examine the external effects of each government's environmental policy on the other country's welfare. When country 1 reduces z_1, the rival firm operating in country 2 expands the prodution and generates more emissions. The external effects are decomposed into following three effects:

1. Environmental damage in country 2 increases. (Negative for country 2)
2. Employment in country 2 increases. (Positive for country 2)
3. Profit of firm in country 2 increases. (Positive for country 2)

These three effects are given by the coefficients of dz_1 in A_3.

Non-cooperative equilibrium can be obtained by setting $(dW_i/dz_i)=0$, with $A_2=A_3=0$.

$$z_i^N = \frac{2\mu c_i - \beta x_i(3\phi_i - 4\mu)}{2\mu\phi_i}, \tag{12}$$

where N denotes the non-cooperative Nash equilibrium.

3.2 Uniform policy reform from Nash equilibrium

The uniform reduction in environmental standards is defined as

$$dz_1 = dz_2 = -\delta . \tag{13}$$

Evaluating the welfare at Nash non-cooperative levels,

$$2dW_i\,|_{z_i=z_i^N} = \phi_i x_i \delta > 0 \tag{14}$$

Thus, we obtain following proposition.

Proposition 1. *Starting from the Nash equilibrium levels, uniform reduction in pollution allowance is welfare-improving for both countries.*

Tougher regulation means the decrease in the firm's profit, however, the improvement of the environmental damage can outweigh the negative effects. Therefore, as long as policy reform takes place uniformly, we can achieve the welfare enhancement for both countries.

3.3 Cooperative equilibrium

From former subsection, we obtain the results that countries get better off by reducing their

environmental standards uniformly. For simplicity, we assume identical technologies and marginal dis-utility of pollution,

$$c_i=c,\ \theta_i=\theta,\ \phi_i=\phi,$$

we pay attention to the cooperative solution.

From the assumption, non-cooperative (and cooperative) solutions become symmetric, *i.e.*, $z_1^N=z_2^N$. In order to find the cooperative equilibrium, we define the total welfare W by adding W_1 and W_2. Totally differentiating W,

$$3\beta\, dW=(A_1+A_3)dz_1+(A_2+A_4)dz_2. \tag{15}$$

Setting the coefficients of dz_i equal to zero and solving simultaneously for z_i, we find the cooperative equilibrium as follows.

$$z_i^c=\frac{\mu c-2\beta x_i(\phi-\mu)-\phi\beta x_j}{\mu\phi}. \tag{16}$$

Comparing the solutions between non-cooperative and cooperative ones, we can state following proposition.

Proposition 2. *The governments impose more restrictive environmental standards under the cooperative equilibrium than that under non-cooperative equilibrium.*

Proof.

$$z_i^N-z_i^c=\frac{\beta\phi x_i+2\phi\beta x_j}{2\mu\phi}>0 \tag{17}$$

This is because the international externalities are negative. Under the cooperative solution governments take into account of $A_2\neq 0$ and $A_3\neq 0$.

4 With Foreign Direct Investment

Consider the case where the foreign firm in country 1 is owned by the foreign multinationals in the rest of the world. One thing should be noted that the profit earned by the firm in country 1 no longer belongs to country 1. Thus, the welfare of the country 1 consists of employment and dis-utility from pollution.

$$W_1=c_1x_1-\phi_1x_1z_1. \tag{18}$$

4.1 Non-cooperative equilibrium

Totally differentiating W_i, we obtain the formulas of welfare changes.

$$3\beta dW_1=B_1 dz_1+B_2 dz_2, \tag{19}$$

$$3\beta dW_2=B_3 dz_1+B_4 dz_2, \tag{20}$$

where

$$B_1=[2\mu c_1-\phi_1(2\mu z_1+3\beta x_1)],$$
$$B_2=\mu[\phi_1 z_1-c_1],$$
$$B_3=\mu[\phi_2 z_2-c_2-2\beta x_2],$$
$$B_4=[2\mu(c_2+2\beta x_2)-\phi_2(2\mu z_2+3\beta x_2)].$$

Non-cooperative equilibrium can be obtained by setting $(dW_1/dz_1)=0$, $(dW_2/dz_2)=0$ and $B_2=B_3=0$.

$$z_1^N=\frac{2\mu c_1-3\beta\phi_1 x_1}{2\mu\phi_1}, \tag{21}$$

$$z_2^N=\frac{2\mu c_2-\beta x_2(3\phi_2-4\mu)}{2\mu\phi_2}. \tag{22}$$

Comparing non-cooperative environmental standards, we have following proposition.

Proposition 3. *Suppose that the FDI only takes place in country 1. When the countries behave non-cooperatively, the country 1, where the firm is owned by foreign multinationals, applies more severe environmental restriction than country 2.*

Proof.

$$z_1^N-z_2^N=-\frac{8(\phi\omega+\mu c)}{\phi(45\phi-28\mu)}<0, \tag{23}$$

where $\omega=(\alpha-\mu\theta-c)=3\beta x_1|_{z_1=z_2=0}>0$.

Recalling that the profit earned by the firm in the country 1 does not belong to country 1, the government of country 1 takes account of welfare change through the employment and environmental damage, whereas the government of country 2 takes care profit of the firm as well as the employment and environment. Comparing z_1^N without FDI to the one in the presence of FDI, we can state that the non-cooperative environmental standard with FDI approaches to the cooperative solution.

4.2 Cooperative equilibrium

Totally differentiating W,

$$3\beta dW=(A_1+A_3)\,dz_1+(A_2+A_4)\,dz_2. \tag{24}$$

Setting the coefficients of dz_i equal to zero, and solving simultaneously for z_i, we find the cooperative equilibrium,

$$z_1^c=\frac{\mu c-\phi(2\beta x_1+\beta x_2)}{\mu\phi}, \tag{25}$$

$$z_2^c = \frac{\mu c - \phi\beta x_1 - 2\beta x_2(\phi - \mu)}{\mu\phi}. \tag{26}$$

Comparing the standards between country with FDI and country without FDI, we can obtain following proposition.

Proposition 4. *Suppose that the FDI only takes place in country 1. Under the cooperative equilibrium, the country 1 applies more restrictive environmental standard than the other country.*

Proof.

$$z_1^c - z_2^c = -\frac{\phi\omega - \mu c}{2\phi(3\phi - 2\mu)} < 0$$

When firm in the country 1 operates through FDI, the environmental standards in cooperative solution differ whereas we have symmetric solution without FDI in the former section. The difference of environmental standards stems from the presence of the FDI. After the foreign multinationals built a production plant in country 1, the substantial fixed cost for investment are already sunk. So the country 1 hosting the FDI can set the environmental standards tougher than country 2.

5 Concluding

We have examined the strategic aspects of environmental standards in third-market model. From the common wisdom in the literature of strategic trade policies, countries can subsidize the firm to extract the rival's profit. This is true to the strategic environmental policies. When countries set their environmental standards non-cooperatively, each country sets relatively laxer level of standard rather than the cooperative optimal.

In this paper we introduce the foreign direct investment in the country 1. We obtain the result that the presence of the FDI causes country to set more tougher regulation.

One thing should be noted that the foreign direct investment in out model is already sunk, hence, the foreign multinational can not relocate the plant to other country. This is a crucial assumption, however, our purpose is to investigate the effect of presence of the FDI on the environmental policies. The internalization of the FDI is interesting question, however, that is beyond the scope of this paper. The further extension with internalization of FDI and political processes in more general settings are analysed in Ishikawa and Kuroda [2004].

References

Barrett, S. (1994): "Strategic environment policy and international trade," *Journal of Public Economics*, 54, 325–338.

Brander, J. A., and B. J. Spencer (1987): "Foreign direct investment with unemployment and endgeneous taxes and tariffs," *Journal of International Economics*, 22, 257–79.

Ishikawa, J., and T. Kuroda (2004): "Firms vs. Environmentalists: Endogenous trade and environmental policies under foreign direct investment," mimeograph.

Kayalica, O. M., and S. Lahiri (2000): "Strategic environmental policies in the presence of Foreign Direct Investment," mimeograph.

Markusen, J. R., E. R. Morey, and N. Olewiler (1993): "Environmental policy when market structure and plant locations are endogenous," *Journal of Environmental Economics and Management*, 24, 69–86.

————(1995): "Competition in regional environmental policies when plant locations are endogenous," *Journal of Public Economics*, 56, 55–77.